

Improvement of Productivity by Using Means of Lean Manufacturing, Just in Time, and Production Technology in Thai SMEs Manufacturing Industry

PIYACHAT BURAWAT
Faculty of Business Administration
Rajamangala University of Technology Thanyaburi, Pathumthani,
THAILAND

Abstract: - This study investigated the current situations, opportunities, and obstacles in manufacturing industry, and to create a model for improving the efficiency while reducing the levels of inventory. This study gathered information from in-depth interview using snowball sampling from 20 manufacturing companies in Thailand. The results revealed that the organization has implemented lean production principles as a strategic initiative to mitigate losses. The implementation of comprehensive work manuals, offered in diverse languages such as Thai, Burmese, Japanese, and English, serves as an additional mechanism to mitigate losses by ensuring clarity and understanding among the workforce. Furthermore, the integration of modern technologies, encompassing machine technology, robotics and artificial intelligence, is actively pursued to streamline production processes and consequently reduce losses. The results presented that companies refrain from adopting Just-In-Time production systems due to operational challenges associated with fulfilling customer orders. Specifically, frequent machine shutdowns for adjustments are necessitated, leading to elevated unit costs. Manufacturing companies in Thailand continue to harbor potential for growth, despite the inevitable rise in employee wages leading to increased operational costs. To navigate this challenging landscape, companies must remain adaptive, responding not only to shifts in customer preferences but also to advancements in technology, proactive examination of customer needs prior to initiating the production process, a paradigm shift from low-cost production to the premium-grade products addresses the demands of customers seeking superior product quality, and the process of broadening customer bases both overseas and globally, and the analysis of distinct customer groups in identifying new target demographics.

Key-Words: - Productivity, Lean Manufacturing, Just in Time, Modern Production Technology, Manufacturing Industry

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1 Introduction

In the current era of globalization, streamlined communication and business operations have intensified competition, necessitating manufacturing and service companies to devise strategies for gaining competitive advantage. Intense competition pervades across all sectors, with manufacturing companies particularly focused on delivering high-quality products, competitive pricing, prompt delivery, and adherence to customer specifications. Moreover, the success of businesses is contingent upon various global economic factors such as product demand, trade policies, market liberalization, and the proliferation of free trade zones worldwide. These factors compel organizations to undergo transformation in order to adapt to evolving organizational landscapes. Recently, there has been a burgeoning emphasis on knowledge-based approaches to confront changing customer demands,

necessitating robust management methodologies. Over successive periods, modern management theories and principles have continuously evolved, with a particular emphasis on novel concepts aimed at enhancing quality and productivity. Furthermore, there is a growing recognition of the significance of technology and information systems in augmenting productivity and quality, prompting increased attention towards their integration into organizational processes.

Labor productivity stands as a pivotal determinant of competitiveness within industries. Not only does it foster enhanced sustainable revenue streams, but it also serves as a critical factor in sustaining competitiveness. Enterprises burdened with elevated operational costs face diminished competitiveness, inevitably leading to financial losses and potential business withdrawal. Thailand's labor productivity growth has been modest, averaging a 2% annual

increase, notably lower compared to countries such as Vietnam and China, where productivity has surged by 4% and 10% respectively [1]. Concurrently, Thailand has witnessed a 3% rise in unit labor costs, while Indonesia has experienced a notable 12% reduction in the same metric [1]. This combination of subdued productivity growth and escalating unit labor costs inevitably diminishes Thailand's overall competitiveness in the global market landscape.

While approximately 70% of manufacturing firms prioritize lean manufacturing, only 26% achieve significant success [2]. Many companies attribute unsatisfactory outcomes to inadequate focus on the supply chain and insufficient encouragement for lean practices implementation. Moreover, some firms, despite winning prestigious awards such as the Shingo Prize, fail to sustain lean programs, resulting in the inability to maintain sustainable results [2]. Successful lean program implementation correlates with several factors, including management attention, goal clarity, active involvement and commitment from all members, empowerment of employees, clear performance metrics, and a well-defined plan for process improvement [3].

The primary advantages commonly attributed to lean manufacturing encompass enhancements in labor productivity, product quality, and reductions in lead time to customers, cycle time, and production costs [4]. However, divergent findings emerge from studies exploring the relationship between lean manufacturing and organizational performance. While some research suggests a positive association between certain aspects of lean manufacturing and organizational performance, others indicate a lack of correlation [5][6]. Furthermore, certain studies indicate that lean manufacturing influences financial performance through its impact on operational performance [7][8].

Inventory stands as a significant asset for numerous companies, often constituting up to 50% of total invested capital. Given its substantial financial implications, effective inventory management is widely acknowledged as pivotal by managers. While reducing inventory can lead to cost savings, the downside entails potential production halts and customer dissatisfaction in instances of stockouts [9].

Companies that have embraced integrated technologies demonstrate notably elevated levels of effort in strategic planning and team-based project management, consequently attaining superior performance across diverse performance metrics compared to their counterparts. Moreover, firms emphasizing the development of human factors appear to reap greater benefits from advanced manufacturing technology implementation [10].

This study endeavors to investigate productivity enhancement within the Thai SME manufacturing industry through the implementation of lean manufacturing, just-in-time practices, and modern production technology. The aim is to provide guidelines for productivity improvement and waste reduction, ultimately enabling enterprises to achieve heightened competitiveness within the manufacturing sector

2 Literature Review

This section elucidates the significance of the research model by elucidating its alignment with established theoretical frameworks pertaining to productivity, just-in-time practices, production technology, and the manufacturing industry.

2.1 Productivity

Productivity is commonly defined as the ratio of outputs or products generated by a manufacturing or service process to the inputs or resources utilized to attain these outputs [11]. Accordingly, productivity entails the efficient utilization of inputs such as labor, machinery, materials, finances, land, information, energy, and management in the production of diverse outputs, encompassing both services and products [12]. Moreover, heightened productivity levels denote achieving greater output quantities or superior product quality with the same input resources [13]. Additionally, productivity can be perceived as the effectiveness and efficiency in job performance [12]. In response to the pervasive and relentless competition spurred by globalization, scholars have argued that the conventional definition of productivity, solely focusing on the quantitative relationship between outputs and resources, is inadequate for assessing organizational effectiveness in contemporary contexts [14][15]. Recent perspectives on productivity advocate for a broader framework that incorporates considerations such as social and ecological costs, adaptability to evolving customer demands, value creation for all stakeholders in the supply chain, resilience in fiercely competitive environments, and agility in responding to customer needs [15][16].

2.2 Just in Time

Just-In-Time (JIT) production is a manufacturing strategy centered on minimizing material inventory by introducing necessary raw materials or components into the production process precisely when needed and in the required quantity. This method avoids warehousing finished products.

Successful JIT implementation requires synchronizing the production system to ensure balanced operations across each stage, evenly distributing working hours. Timely introduction of raw materials is crucial, requiring collaboration with suppliers [17].

The effective operation of JIT production hinges upon establishing strong relationships among raw material suppliers, production lines, and marketing units. A cohesive network ensures timely raw material delivery, enhancing overall production chain efficiency. Any component or process failure has significant ramifications, impeding prompt product production and highlighting the interdependence among involved entities. Thus, the absence of timely input disrupts the delicate balance of the JIT system, hindering production workflow and compromising the objective of timely product delivery [9].

2.3 Production Technology

Technology plays a critical role in modern production methods, driving efficiency, cost reduction, and product quality enhancement. In today's business landscape, technology is indispensable, exerting a significant influence on production methodologies. It has transformed business operations, fostering the emergence of more streamlined and economical production processes. Automation stands out as a prominent manifestation of technological advancement in production. Leveraging robotics and artificial intelligence, automation has supplanted manual labor across various industries, resulting in heightened productivity and diminished labor expenses. For example, within the automotive sector, robots deployed in assembly lines execute repetitive tasks with precision and swiftness, amplifying output and minimizing errors.

Furthermore, technology has facilitated the implementation of advanced production techniques such as Just-In-Time (JIT) and lean manufacturing. These methodologies heavily rely on sophisticated software systems for inventory management, scheduling, and quality control. For instance, JIT, which aims to minimize waste by producing goods only when needed, necessitates accurate forecasting and real-time tracking of inventory levels, made feasible by technology. Moreover, technology plays a crucial role in enhancing product quality. Computer-Aided Design (CAD) and Computer-Aided Manufacturing (CAM) enable precise design and production, reducing the likelihood of defects and ensuring consistency in product quality. Additionally, technology enables stringent quality control through automated inspection systems

capable of detecting flaws that may elude human inspectors. Furthermore, technology has enabled the adoption of flexible manufacturing systems, permitting the production of a variety of products on the same production line. This flexibility is particularly advantageous in industries where product differentiation is pivotal for competitive advantage. For instance, in the electronics sector, companies can swiftly transition from producing one type of device to another, responding promptly to shifts in market demand [18].

Advanced digital production technologies encompass a wide array of innovations, including new materials, the Internet of Things (IoT), big data analysis, advanced robotics, cloud computing, additive manufacturing, artificial intelligence (AI) supported manufacturing, nano and biotechnological production. These emerging technologies are poised to impact numerous sectors in the future, albeit not instantaneously. The integration of these technologies into industries is expected to occur gradually and organically. Once production facilities incorporate technology into their workflows, smart production platforms will emerge, characterized by data sharing, deep learning networks, AI, IoT, and remote-controlled machine and hardware integration. Consequently, traditional production areas and machines are anticipated to occupy a smaller percentage of factories [18].

2.4 Manufacturing Industry

The manufacturing industry encompasses sectors involved in the production and processing of goods, contributing to either the creation of new commodities or value addition. This sector holds a substantial share of the industrial sector in developed countries, with final products serving as finished goods for sale to customers or intermediate goods for use in further production processes.

In 2021, Thailand's GDP structure delineated the service sector as the predominant economic activity, comprising 60% of the GDP, followed by the manufacturing and agriculture sectors, constituting 32% and 8%, respectively [19]. The GDP of the SME sector in 2022, categorized by SME sizes, amounted to 6,105,604 million baht, representing 34.5% of total GDP [20]. Further analysis of the GDP structure for small and medium-sized businesses revealed the service sector as the most significant activity, accounting for 43.6%, followed by the manufacturing sector at 35.4%. The retail and wholesale sector and the agricultural business sector represented proportions of 20.5% and 0.5%, respectively [20].

The study revealed that Thailand is ranked 35th in terms of industrial potential, with seven Thai

industries positioned among the top 15 globally. These include the coking coal and oil refining products industry (9th), the rubber and plastic industry (9th), the food and beverage production industry (11th), the health industry (11th), the recreation industry (13th), the retail and wholesale industry (14th), and the textile industry (15th). Conversely, Thai industries positioned in the bottom three globally encompass the construction industry (64th), the education industry (60th), and the IT industry (61st) [21].

Interestingly, other ASEAN countries also exhibit industries with significant potential, with Vietnam excelling in the clothing and textile industry, Singapore leading in financial and computer-related affairs, and Indonesia ranking fifth in food and drink proficiency. This data suggests that neighboring countries may experience rapid development, posing increased competition for Thailand in the coming years [21]. Given the aforementioned context, the sample population for this study comprised executives and managers employed within the manufacturing industry in Thailand.

In conclusion, lean manufacturing, just-in-time practices, and advanced digital production technologies play a pivotal role in modern production methods. These methodologies enhance efficiency, reduce costs, and improve product quality, thereby enabling businesses to maintain competitiveness in the dynamic global market landscape.

3 Research Methodology

The study employed a qualitative approach, utilizing in-depth interviews conducted through snowball sampling with 20 participants comprising managing directors, executives, production managers, and sales managers from 20 companies. Data collection took place from March 2023 to March 2024, and analysis was conducted using content analysis techniques.

4 Research Results

The study comprised primarily companies from the automotive industry (20), followed by the food and beverage industry (5), construction industry (3), electric and electronic industry (3), garment and textile industry (2), plastic industry (1), energy industry (1), rubber industry (1), cosmetic industry (1), machinery industry (1), and thermoplastic paint industry (1).

4.1 Lean Manufacturing Practices

Participants reported that their organizations have adopted lean production principles strategically to mitigate losses, focusing on minimizing losses attributed to employee errors and machine inefficiencies during production. Various methodologies have been deployed to address employee-related losses, including rigorous quality assessments of raw materials, thorough scrutiny of work processes, and meticulous inspection of machinery and equipment. Additionally, measures such as employee training programs are emphasized to enhance skills and bolster pre-production preparedness, further contributing to loss prevention efforts.

The provision of comprehensive work manuals, available in multiple languages including Thai, Burmese, Japanese, and English, is employed as a supplementary measure to mitigate losses by promoting clarity and comprehension among the workforce. Additionally, the incorporation of modern technologies such as robotics and artificial intelligence (AI) is actively pursued to optimize production processes and minimize losses. This multifaceted approach highlights the organization's dedication to adopting contemporary tools and methodologies to enhance resilience against losses incurred during the production phase.

Addressing losses stemming from machine failures necessitates a multifaceted approach, including robust employee training initiatives. These programs aim to equip personnel with essential skills for proficient machinery operation and basic maintenance tasks. Encouraging employee engagement in ongoing machine monitoring, alongside a streamlined reporting system for identified issues, facilitates swift problem resolution. Moreover, promoting a culture of employee engagement in ongoing machine monitoring, coupled with a responsive reporting mechanism for identified issues, facilitates prompt problem resolution.

The proactive involvement described above demonstrates its effectiveness in swiftly resolving machine problems, resulting in a reduction of associated losses. Central to this strategy is addressing the challenge of producing substandard products, with artificial intelligence (AI) playing a pivotal role. AI technologies are utilized to analyze machine-generated data, enabling precise diagnostics of problems. Subsequent repairs are aligned with identified machine issues, thereby minimizing losses related to the production of inferior-quality products. Moreover, the incorporation of AI enables nuanced analysis to formulate strategic plans for timely and appropriate maintenance interventions. This forward-

looking approach optimizes maintenance schedules, ensuring that corrective actions are implemented judiciously, thereby reinforcing the organization's resilience against losses resulting from machine failures.

4.2 Just in Time Practices

Participants revealed that the organization has implemented a Just-In-Time (JIT) production system strategically to improve operational efficiency by minimizing or eliminating inventory and ensuring timely deliveries to customers. Orders from customers are typically placed within a 10-15 day window before the designated delivery date. Unlike conventional practices, where production planning begins post-receipt of customer orders, the company adopts a proactive approach to streamline production processes. Upon order receipt, the purchasing department initiates raw material procurement, coordinating deliveries from suppliers at a frequency of 1-2 rounds per day. This scheduling minimizes raw material storage space in the warehouse, reducing associated costs and time spent locating materials. The production department, informed by customer orders, dispenses raw materials in required quantities.

Concurrently, the shipping or distribution department meticulously plans truck routes to optimize efficiency, coordinating routes to prevent unnecessary diversions and ensure coherent paths. Such strategic route planning is crucial in avoiding redundant detours and associated time wastage. Moreover, goods are loaded during both outbound and return truck journeys to prevent empty vehicle returns to the company premises. This concerted effort aligns with the JIT philosophy, contributing to the organization's goal of waste reduction and logistical efficiency enhancement across the supply chain.

Concurrently with production processes, the shipping or distribution department carefully strategizes truck routes to maximize efficiency, ensuring coherent paths and minimizing unnecessary diversions. This strategic route planning is essential to avoid redundant detours and time wastage. Additionally, goods loading is coordinated during both outbound and return truck journeys to avoid empty vehicle returns to the company premises. This concerted effort aligns with the Just-In-Time (JIT) philosophy, supporting the organization's objective of waste minimization and logistical efficiency improvement across the supply chain.

Participants highlighted that some companies hesitate to adopt Just-In-Time (JIT) production systems due to operational hurdles in meeting

customer orders. Notably, frequent machine shutdowns for adjustments incur higher unit costs. Additionally, the procurement of raw materials from suppliers presents challenges, as it mandates meeting minimum purchase requirements stipulated by the suppliers, thus necessitating the acquisition of larger quantities of raw materials to comply with supplier conditions.

To tackle these challenges, one alternative strategy involves establishing a production contract between the company and its customer. In this framework, the customer forecasts production orders in advance, enabling proactive planning by the company for raw material procurement and production scheduling. This approach allows the company to place bulk orders for raw materials and conduct large-scale production runs, ultimately reducing unit production costs. However, it also leads to increased inventory storage costs due to the higher volume of goods held in storage.

In essence, the negotiated production contract serves as a strategic compromise, enabling the company to balance considerations of unit production costs with inventory storage expenses. This tailored approach aims to optimize operational efficiency and cost-effectiveness, navigating the complex trade-offs inherent in JIT production systems and their implications for the overall economic viability of the production process.

4.3 Production Technology Applications

Participants underscored contemporary challenges encountered by production companies, especially those heavily dependent on human labor, including rising labor costs resulting in workforce reductions. Despite increased labor mobility facilitated by ASEAN integration, particularly through the ASEAN Economic Community (AEC), escalating wages and labor shortages persist as critical concerns for manufacturing entities.

To tackle these challenges, companies primarily rely on machine technology as their primary production methodology. Automated machinery, controlled by computer systems, is favored to mitigate errors associated with human labor. Complementing this automation, the integration of sensor systems assists in both production processes and product quality inspection. The incorporation of software is instrumental in organizational resource management, helping to mitigate operational errors. The real-time and current data updates facilitated by these technologies contribute to enhanced interdepartmental coordination.

Moreover, the integration of Artificial Intelligence (AI) into production processes and machinery

functions as an advanced analytical tool. AI plays a crucial role in accurately identifying and analyzing problems, providing timely and effective solutions. This multifaceted technological integration not only improves the precision of issue detection but also streamlines the problem-solving process, exemplifying a comprehensive approach to addressing challenges in both production and machinery domains.

5 Discussions and Conclusions

Manufacturing companies in Thailand retain growth potential despite rising employee wages, which elevate operational costs. To navigate this challenging scenario, companies must remain adaptive, responding to both customer preferences and technological advancements [22]. A key aspect of adaptability is proactively assessing customer needs before commencing the production process. Through comprehensive surveys, companies can glean valuable insights into evolving customer requirements.

Moreover, investing in research and development to explore innovative product formats facilitates market expansion, particularly in international arenas, streamlining the process of broadening customer bases both overseas and globally. Analyzing distinct customer groups is imperative in identifying new target demographics. Additionally, shifting focus from traditional goals of low-cost production to creating premium-grade products addresses the demands of customers seeking superior product quality.

In looking towards the future, the integration of advanced production technologies such as robotics and Artificial Intelligence (AI) emerges as a strategic imperative [23]. These technologies offer a dual advantage by reducing production costs and enhancing competitiveness. As manufacturing enterprises in Thailand realign their strategies in response to dynamic market forces and technological advancements, the prudent adoption of these innovations is poised to play a pivotal role in sustaining and advancing their competitiveness in the global marketplace.

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Assistant Professor Burawat Piyachat, Ph.D.
Lecturer in management, Rajamangala University of Technology Thanyaburi
Mailing address: 4th Building, 6th Floor, Faculty of Business Administration, Major Management, Rajamangala University of Technology Thanyaburi, 39 Moo1, Klong6, Thanyaburi, Pathumthani, Thailand, 12110, piyachat_b@rmutt.ac.th

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